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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/902,728	07/12/2001	Arpan P. Mahorowala	YOR920000789US1	9522

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EXAMINER

BARRECA, NICOLE M

ART UNIT	PAPER NUMBER
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1756

DATE MAILED: 10/27/2003

8

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/902,728

Applicant(s)

MAHOROWALA, ARPAN P.

Examiner

Nicole M. Barreca

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 August 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-26 is/are pending in the application.
- 4a) Of the above claim(s) 18, 19 and 22-26 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-17, 20 and 21 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

1. Claims 1-26 are pending in this application. Claims 18, 19, 22-26 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in Paper No. 5.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1-3, 7-10, 17, 20-21 are rejected under 35 U.S.C. 102(e) as being anticipated by Ngo (US6528432) with Linn (US 5833758) cited to show inherent properties.

4. Ngo discloses a H₂ or H₂/N₂ plasma treatment in order to prevent organic ILD degradation. Figure 4 illustrates interlayer dielectric (ILD) 50 overlying a substrate. ILD 50 may comprise an organic carbon-containing low-k material. An organic carbon-containing low-k ILD 52, such as SiOCH (applicant's organic underlayer), is formed over layer 50 and patterned to form a trench using conventional damascene techniques (i.e. photoresist patterning, transferring photoresist pattern to underlying layer). Exposed surfaces are treated with H₂ or H₂/N₂ plasma in order to reduce pattern degradation,

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prior to photoresist stripping. Metal is deposited in the trench to form conductive line 70. See col.5, 54-col.6, 26 and figure 5. Ngo teaches using a H₂ or H₂-containing plasma in order to prevent degradation of a resist pattern in the subsequent processing steps. Ngo however does not explicitly state that this H₂ or H₂-containing plasma is a chemically reducing plasma. However Linn teaches that H₂ is a chemically reducing plasma (col.3, 16-44), thereby teaching that the H₂ plasma used in the method of Ngo is inherently a chemically reducing plasma.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 11-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo (with Linn cited to show inherent properties), as applied to claim 1, and further in view of Allen (US 5985524).

Ngo is silent on the specific details the damascene patterning process, such as on the specific photoresist material and exposure radiations used and does not disclose that the photoresist material comprises an element selected from Si, P, Ge, Al and B (cl.2), that the photoresist comprises a polymer having acid-cleavable moieties (cl.11), that the photoresist comprises a polymer formed by polymerizing one or more monomers selected from acrylate, methacrylate, hydroxystyrene, cyclic olefin and having silylethoxy acid-cleavable moieties (cl.12), that the photoresist comprises a

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photoacid generator (cl.13), or that the radiation comprises electromagnetic or e-beam radiation (cl.14), UV or EUV (cl.15) or x-ray radiation (cl.16).

Allen discloses a method for forming bilayer resist images for use in the manufacture of integrated circuits. Conventionally the top layer of the bilayer resist contains silicon, boron or germanium which enable the use of oxygen reaction ion etching in the image transfer step. However the incorporation of silicon in the photoresist leads to resolution degradation. This bilayer method improves resolution and critical dimension (col.1, 37-56, cl.17). The top photoresist imaging layer comprises a photoacid generator. The photoresist also may comprise a polymer formed by polymerizing one or more monomers selected from acrylate, methacrylate, hydroxystyrene, cyclic olefin and having silylethoxy acid-cleavable moieties (col.2, 11-65, cl.2, 11-13). The photoresist is coated on an underlying organic layer, such as a low-k dielectric (col.3, 41-48, cl.9-10). The top layer is imagewise exposed to radiation such as UV, EUV, and x-ray (col.4, 13-21, cl.14-16). It would have been obvious to one of ordinary skill in the art to use photoresist material comprising a material selected from Si, P, Ge, Al and B, comprising a polymer formed by polymerizing one or more monomers selected from acrylate, methacrylate, hydroxystyrene, cyclic olefin and having silylethoxy acid-cleavable moieties, and comprising a photoacid generator, and to expose the photoresist using electromagnetic, UV, EUV or x-ray radiation, as the photoresist for the damascene patterning in the method of Ngo (w/ Linn cited to show inherent properties) because Allen teaches that these photoresist and exposure radiations produce a bilayer resist image with improved resolution.

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7. Claims 4-6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo (with Linn cited to show inherent properties), as applied to claim 1, and further in view of Ni (US 6465159).

The teachings of Ngo have been discussed above. Ngo is silent on the method and gases used for transferring the trench pattern to the organic low-k underlayer, teachings only that the trench pattern is formed using conventional damascene techniques. Ngo therefore does not disclose that the (trench) pattern is transferred by etching using passivating chemistry which generates hygroscopic moieties such as a SO₂/O₂ containing plasma. Ni teaches that a conventional etch of organic low-k materials in a plasma chamber typically uses gases such as O₂, CO₂ and SO₂ (col.1, 48-50). It would have been obvious to one of ordinary skill in the art to transfer the (trench) pattern to the low-k organic layer in the method of Ngo (w/ Linn cited) by etching with a plasma containing O₂ and SO₂ gases because Ni teaches that a conventional etch of organic low-k materials in a plasma chamber typically uses gases such as O₂, CO₂ and SO₂.

Response to Arguments

8. Applicant's arguments, filed 8/1/03, with respect to the rejection(s) of the claims under 102 and 103 have been fully considered and are persuasive. Therefore, the rejections have been withdrawn. However, upon further consideration, a new ground(s) of rejection has been made.

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Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Gu (US 6562700) discloses removing a resist mask over a low-k carbon doped silicon oxide dielectric layer by exposing the resist to a reducing plasma of NH₃, H₂, forming gas or a NH₃/H₂ mixture. Collins (US 4904866) and Tsai (US 5688719) disclose chemically inducing the hardening of a photoresist pattern using H₂ plasma.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nicole M. Barreca whose telephone number is 703-308-7968. The examiner can normally be reached on Monday-Thursday (8:00 am-6:30 pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.



Nicole Barreca
Patent Examiner
Art Unit 1756
10/20/03